PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2000-339605

(43)Date of publication of application : 08.12.2000

---

(51)Int.Cl. G11B 5/02
G11B 5/64
H01F 41/20

---

(21)Application number : 11-142846 (71)Applicant : MATSUSHITA ELECTRIC IND CO LTD

(22)Date of filing : 24.05.1999 (72)Inventor : YOSHIDEN HIDEKI

---

(54) MAGNETIC RECORDING METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a good electromagnetic conversion characteristic in linear recording by moving a magnetic tape using a cobalt obliquely deposited film having a thickness equal to half or lower of a recording head gap length in both directions with respect to the recording head and then performing recording.

SOLUTION: A cobalt obliquely deposited film having a thickness equal to 1/2 or lower of a recording head gap length is used. Thus, by setting the length equal to half or lower, signal interference is prevented in a depth direction, and a recording characteristic is thereby improved in a reverse direction. An output difference is very small between the forward and backward directions, recording currents are similar, and thus interference with high-density recording is prevented. Also, by using an MR element as a reproducing head, especially the MR element having a large output improving effect in a long wavelength side of a slow relative speed, the specified disadvantage is eliminated. Further, a recording head gap length is set equal to 0.25 micron or lower. Thus, a large demagnetizing effect, and the deterioration of an electromagnetic conversion

characteristic in the reverse direction, which occur when the recording head gap length is long, are prevented.

LEGAL STATUS [Date of request for examination] 14.05.2002
[Date of sending the examiner's decision of rejection] 30.06.2003
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]
[Date of final disposal for application]
[Patent number]
[Date of registration]
[Number of appeal against examiner's decision of rejection]
[Date of requesting appeal against examiner's decision of rejection]
[Date of extinction of right]

CLAIMS

[Claim(s)]
[Claim 1] The magnetic-recording approach characterized by what the magnetic tape using the method vacuum evaporationo film of cobalt system slanting moves and records on both directions to a recording head using the method vacuum evaporationo film of cobalt system slanting of 1/2 or less thickness of record head gap length.
[Claim 2] The magnetic-recording approach according to claim 1 characterized by using MR component as the reproducing head.
[Claim 3] The magnetic-recording approach according to claim 1 characterized by the head gap length of a recording head being 0.25 microns or less.
[Claim 4] The magnetic-recording approach according to claim 1 characterized by ** whose holding power of the method vacuum evaporationo film of cobalt system slanting is 1800 or more oersteds.
[Claim 5] The magnetic-recording approach according to claim 1 characterized by ** whose thickness of the method vacuum evaporationo film of cobalt system slanting is 10 nanometers or more.
[Claim 6] The magnetic-recording approach according to claim 1 characterized by ** whose thickness of the method vacuum evaporationo film of cobalt system slanting is 40 nanometers or less.
[Claim 7] The magnetic-recording approach according to claim 1 characterized by

having a diamond system carbon protective coat.

[Claim 8] The magnetic-recording approach according to claim 1 characterized by consisting of method vacuum evaporationo film of cobalt system slanting of a monolayer.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the magnetic-recording approach which records while moving the magnetic tape which used the method vacuum evaporationo film of cobalt system slanting to both directions to a recording head.

[0002]

[Description of the Prior Art] In recent years, the densification of magnetic recording progressed, the magnetic-recording medium which can realize high surface recording density was developed, and the spreading mold metal tape using metal particles and the metal thin film mold magnetic tape using a vacuum deposition technique were put in practical use. It is known by using the method vacuum evaporationo film of cobalt system slanting for a magnetic layer as a metal thin film mold magnetic tape especially that the high performance magnetic tape (it is called an A-ME tape below) using a diamond system carbon protective coat shows the property excellent in a magnetic parametric performance, shelf life, practical use dependability, etc.

[0003] The current A-ME tape is used as a tape for data storage of 8mm width of face while being used for the movie of DV method which is a digital image record device etc. Since it can make easily a tape thinner than the conventional spreading mold tape, an A-ME tape fits the data storage devices which need mass record, while having the outstanding property.

[0004] It is a recording method using the rotating drum known as a helical scan each that current and an A-ME tape are used. Although a helical scan is an outstanding recording method suitable for high density record, the easy linear method of structure is improved as an object for data storage in recent years. A linear method is a method used from the device before a helical scan, and is a method which forms a truck crosswise [of a magnetic tape] and records on a longitudinal direction.

[0005] Since it is necessary to make a magnetic tape incline in the helical direction in a helical scan and becomes a complicated transit system, when making it run a tape at high speed if exact control is not performed for example, the big force may act on a tape edge and an edge damage may be produced. By the linear method, since it is easy to make it run a tape at high speed and access nature is good, it has been improved as an

object for data storage in recent years.

[0006] Here, although an A-ME tape has the outstanding property, it is not used for a linear method. This biggest cause is because it moves by the linear method to both directions to the relative motion of a magnetic tape and the magnetic head being decided to be an one direction in the helical scan.

[0007] The magnetic layer of an A-ME tape is formed by the reactant vacuum deposition method which used the method vacuum evaporationo technique of slanting. The easy magnetization direction of a magnetic layer is the direction of the method of slanting to which it inclined not out of field inboard but out of the field, therefore it is known that the direction used as the direction which serves as high power according to the direction to record, and low-power output exists. Therefore, in high density record, it is known that it is suitable for the helical scan recorded only in the fixed direction, and it is not suitable for the linear recording method recorded on both directions.

[0008] Hereafter, the conventional magnetic-recording approach is explained based on a drawing. Drawing 3 is the mimetic diagram showing the conventional magnetic-recording approach, 3 is a recording head and 4 is the method vacuum evaporationo film of cobalt system slanting. The method vacuum evaporationo film 4 of cobalt system slanting was vapor-deposited in the oxygen ambient atmosphere along with the cooling drum by having used cobalt as the hardener (patent registration number No. 1168849), and was 0.18 microns in thickness measurement of the magnetic layer by the scanning electron microscope. The head gap length of a recording head 3 was 0.20 microns from the check of an electric null point. The holding power of the method vacuum evaporationo film 4 of cobalt system slanting was 1400 oersteds.

[0009] In the high density magnetic recording on the A-ME tape using the method vacuum evaporationo film 4 of cobalt system slanting, as for magnetic layer thickness, about 0.18 to 0.25 microns is used from 0.15 microns, as for 0.20 microns and head gap length. If this is chosen from the record capacity of a recording head 3, or the recording characteristic of the method vacuum evaporationo film 4 of cobalt system slanting and a magnetic layer is made thin more than this, it is known that an output will decline and the thickness of the method vacuum evaporationo film 4 of cobalt system slanting is comparable as the head gap length of a recording head 3.

[0010] As hatching the inside of drawing 3 and within the method vacuum evaporationo film 4 of cobalt system slanting shows the sense of column structure and shows it to the arrow head in drawing, the direction to which a recording head 3 and the column of the method vacuum evaporationo film 4 of cobalt system slanting move relatively is the forward direction, and the reverse is hard flow. By drawing 3 , the record condition of the method vacuum evaporationo film 4 of cobalt system slanting by the recording head 3 at the time of moving in the direction of an arrow head is shown, record is performed near the center of a recording head 3, and it is thought that a demagnetization field exists in the back end part of a recording head 3.

[0011] If it is the forward direction, since the field which a recording head 3 generates in a demagnetization field differs from the easy magnetization direction of the method vacuum evaporationo film 4 of cobalt system slanting greatly, it is thought that demagnetization does not occur. If it is hard flow, since the field which a recording head 3 generates in a demagnetization field is mostly in agreement with the easy magnetization direction of the method vacuum evaporationo film 4 of cobalt system slanting, it is thought that demagnetization occurs (Nochi, other:IEEE Trans.on Magn.MAG-22, pp 385-387, "Analysis due to vector magneticfield for recording characteristics of metal evaporated tape", 1986).

[0012] Here, an example of actual record reproducing characteristics is shown in drawing 4 . In the forward direction, an output increases with the increment in a record current, and even if it makes a record current high more than the saturation point, an output seldom changes. On the other hand, in hard flow, although the output increases with increase of a record current, the saturation point comes with a record current lower than the forward direction, and the maximum output is lower than the forward direction. If a record current is furthermore raised, the playback output decreases. That is, although a high output is obtained to the forward direction under the effect of the method magnetic layer of slanting since the A-ME tape uses the method vacuum evaporationo film of cobalt system slanting as a magnetic layer, the output of hard flow becomes low.

[0013] Although the A-ME tape is used for record of only an one direction as mentioned above, the method of reducing directivity is also learned. Although it is the approach of carrying out the laminating of the method vacuum evaporationo film of cobalt system slanting to a multilayer and had directivity in the monolayer, by carrying out a laminating to a multilayer, it cancels directivity, there is and it can make the output difference by the record direction small (Yoshida, Other : Journal of the Magnetics Society of Japan, Vol.13, No.S1, pp139-144, "High-density magnetic recording properties of Co-nickel-O thin film", 1989).

[0014] Thus, when it multilayered, although directivity was lost, the number of processes of magnetic layer formation will increase, a manufacturing cost will go up, by linear record, since recording density was lower than a helical scan, the magnetic tape of a large area was needed, and the problem of a manufacturing cost had turned into a serious problem.

[0015]

[Problem(s) to be Solved by the Invention] If it is going to use the method vacuum evaporationo film of cobalt system slanting of a monolayer with a cheap manufacturing cost for linear record in the conventional example, in linear record, the migration direction of a tape will serve as the magnetic head and relative relation of the method vacuum evaporationo film of cobalt system slanting as it is. That is, it cannot be used only in the forward direction of drawing 4 , but must be used also in hard flow.

Although the maximum output difference of the forward direction and hard flow is about 3dB in drawing 4 , an effectual record current increases by wear of the magnetic head, and in order to improve an over-writing property, the record current of a high eye is used in many cases. Therefore, a substantial output difference is 5dB or more, and the good property was not acquired in hard flow.

[0016]

[Means for Solving the Problem] In order to solve the above-mentioned conventional technical problem, the method vacuum evaporationo film with a thickness of 80 nanometers or less of cobalt system slanting is used for this invention, and it is characterized by what a magnetic tape moves and records on both directions to the magnetic head.

[0017] Thereby, a manufacturing cost becomes realizable [a good magnetic parametric performance] by linear record using the method vacuum evaporationo film of cobalt system slanting of a cheap monolayer.

[0018]

[Embodiment of the Invention] Invention of this invention according to claim 1 can be made into the magnetic-recording approach that the magnetic tape using the method vacuum evaporationo film of cobalt system slanting is characterized by what is moved and recorded on both directions to a recording head, using the method vacuum evaporationo film of cobalt system slanting of 1/2 or less thickness of record head gap length, and, thereby, can reduce the directivity of an output.

[0019] It is thought by making thin thickness of the method vacuum evaporationo film of cobalt system slanting that it is because the loss of power of hard flow is not only the demagnetization by the easy magnetization direction simply that directivity is eased sharply. That is, when carrying out hard flow record by the conventional thickness of 150 nanometers or more, record conditions differ in the shallow part of the thickness direction, and a deep part, and the method vacuum evaporationo film of cobalt system slanting is considered that the output was declining further by mutual interference. By making thickness of the method vacuum evaporationo film of cobalt system slanting below into one half extent, signal interference of the depth direction is prevented and it is thought that it becomes improvable [the recording characteristic of hard flow]. Although it was the approach which especially the thing for which thickness is made thin makes the output by the side of long wavelength reduced sharply, also becomes a demerit, and cannot be considered conventionally, this demerit can be prevented to some extent by record playback system optimization.

[0020] Invention of this invention according to claim 2 can prevent the above-mentioned demerit by considering as the magnetic-recording approach according to claim 1 characterized by using MR component as the reproducing head, and using large MR component of especially an output improvement effect by the long wavelength side with a slow relative velocity.

[0021] It considers as the magnetic-recording approach according to claim 1 characterized by the head gap length of a recording head being 0.25 microns or less, when record head gap length is long, the demagnetization effectiveness increases, and invention of this invention according to claim 3 can avoid that the magnetic parametric performance of hard flow deteriorates.

[0022] Invention of this invention according to claim 4 considers as the magnetic-recording approach according to claim 1 characterized by ** whose holding power of the method vacuum evaporationo film of cobalt system slanting is 1800 or more oersteds, and its demagnetization effectiveness is large at the holding power of conventional 1500 oersted extent, and it can improve the point that the magnetic parametric performance of hard flow had deteriorated.

[0023] Invention of this invention according to claim 5 is that the thickness of the method vacuum evaporationo film of cobalt system slanting considers as the magnetic-recording approach according to claim 1 characterized by ** which is 10 nanometers or more, and makes thickness of the method vacuum evaporationo film of cobalt system slanting 10 nanometers or more, and can secure the holding power of 1800 or more oersteds.

[0024] Invention of this invention according to claim 6 is that the thickness of the method vacuum evaporationo film of cobalt system slanting considers as the magnetic-recording approach according to claim 1 characterized by ** which is 40 nanometers or less, and makes thickness of the method vacuum evaporationo film of cobalt system slanting 40 nanometers or less, the problem of signal interference of it is lost, and a good magnetic parametric performance is acquired.

[0025] Invention of this invention according to claim 7 can secure sufficient magnetic parametric performance and practical use dependability by considering as the magnetic-recording approach according to claim 1 characterized by having a diamond system carbon protective coat, and using a diamond system carbon protective coat.

[0026] Invention of this invention according to claim 8 considers as the magnetic-recording approach according to claim 1 characterized by consisting of method vacuum evaporationo film of cobalt system slanting of a monolayer, and fits the method vacuum evaporationo film of cobalt system slanting of a monolayer with a cheap manufacturing cost to linear record.

[0027] Hereafter, the gestalt of operation of this invention is explained, referring to a drawing.

[0028] (Gestalt 1 of operation) Drawing 1 is the mimetic diagram of the magnetic-recording method of this invention. In drawing 1 , 1 is a recording head and 2 is a cobalt system thin layer magnetic film. The thickness of considering as a thin layer here is 1/2 or less thing of the head gap length of a recording head 1. In drawing 1 , although an arrow head shows the relative migration direction of a recording head 1 and the cobalt system thin layer magnetic film 2, especially the sense of the column

structure of the cobalt system thin layer magnetic film 2 is not limited. The direction used by drawing 3 for distinction is made into the forward direction, and the reverse direction will be called hard flow.

[0029] The head gap length of a recording head 1 was 0.18 microns, head width of face was 4 microns, the cobalt system thin layer magnetic film 2 was formed by the monolayer, and thickness was [the saturation magnetic flux density in 0.75 and a magnetic film with average 1900 oersteds and remanence ratio of 0.06 microns (60 nanometers) and holding power] 5200 gauss.

[0030] Record reproducing characteristics were checked on the relative-velocity 10 m/min. record wavelength of 0.5 microns the above condition. The result of the record reproducing characteristics when using an MR head with a head width of face of 3.5 microns for the reproducing head is shown in drawing 2 .

[0031] In drawing 2 , the output difference of the forward direction and hard flow is 1.3dB, and the record current characteristic is also alike. This differs from drawing 4 of the conventional example greatly, and if it is the property of drawing 2 , even if it is hard flow, there is no big trouble in practice to high density record. By drawing 2 , to only the primary demagnetization effectiveness by the record direction of the method record of slanting having become the difference of directivity, and appearing, since the secondary loss by phase contrast had occurred to the depth direction of a magnetic layer in addition to primary effectiveness, it thinks at drawing 4 of the conventional example.

[0032] (Gestalt 2 of operation) In order to deepen a quantitive understanding about this invention, the method vacuum evaporationo film of cobalt system slanting was created on condition that various kinds, and the magnetic parametric performance was measured. Each magnetic layer was vapor-deposited by the monolayer by the incident angle of the 45 minimum include angles in the oxygen ambient atmosphere by using cobalt as a hardener. The conditions of record playback are the same as the gestalt 1 of operation, and the head gap length of a recording head is 0.18 microns (180 nanometers). It is this result [0033]

[Table 1]

	磁性層厚み（ナノメートル）	保持力（エルステッド）	方向性による出力差（デシベル）	
サンプル１	１５０	１８２０	３．６	従来例
サンプル２	１１０	１８１０	２．２	参考例
サンプル３	８０	１８２０	１．５	実施例
サンプル４	６０	１８３０	１．３	実施例
サンプル５	４０	１８２０	１．１	実施例
サンプル６	３０	１８３０	１．１	実施例
サンプル７	２０	１８４０	１．１	実施例
サンプル８	１０	１６３０	１．４	実施例
サンプル９	７	１４１０	１．８	実施例

[0034] It is alike and is shown.

[0035] Samples 1 and 2 have a large output difference by directivity compared with other samples, and the output difference by directivity is less than 2dB, and, as for samples 3-7, it turns out that there is no big problem in record in both directions practically so that more clearly than (Table 1). Moreover, although directivity fell by lowering magnetic layer thickness by the magnetic layer thickness of 40 nanometers or more, the effectiveness is lost by the magnetic layer thickness of 40 nanometers or less. This is considered to be a phenomenon resulting from the particle-size limitation of the method vacuum evaporationo film of cobalt system slanting. Moreover, when magnetic layer thickness was made into 10 nanometers or less, holding power declined, and the inclination for directivity to increase again was checked.

[0036] In addition, although not clearly written about a diamond system carbon protective coat in the gestalt of operation, all prepare a protective coat with a thickness of 10 nanometers with a CVD method, and use fluorine system lubricant with a thickness of 4 nanometers further. Moreover, although the hardener of the method vacuum evaporationo film of cobalt system slanting was used as cobalt, already known alloying elements, such as nickel, may also be included. Moreover, it is common to use various kinds of giant-molecule substrates, such as polyethylene terephthalate, polyethylenenaphthalate, a polyamide, and polyimide, as a base material used in case the method vacuum evaporationo film of cobalt system slanting is formed, and it is common to prepare a back coat layer in the forming face and the opposite side of the method vacuum evaporationo film of cobalt system slanting.

[0037]

[Effect of the Invention] When the magnetic tape using the method vacuum evaporationo film of cobalt system slanting moves and records on both directions to a recording head in this invention using the method vacuum evaporationo film of cobalt system slanting of 1/2 or less thickness of record head gap length as mentioned above, the magnetic parametric performance which was excellent to both directions is realized.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The mimetic diagram showing the magnetic-recording approach in the gestalt 1 of operation of this invention

[Drawing 2] Drawing showing the record reproducing characteristics in the magnetic-recording approach in the gestalt 1 of operation of this invention

[Drawing 3] The mimetic diagram showing the conventional magnetic-recording approach

[Drawing 4] Drawing showing the record reproducing characteristics in the conventional magnetic-recording approach

[Description of Notations]

1 Recording Head

2 Method Vacuum Evaporationo Film of Cobalt System Slanting